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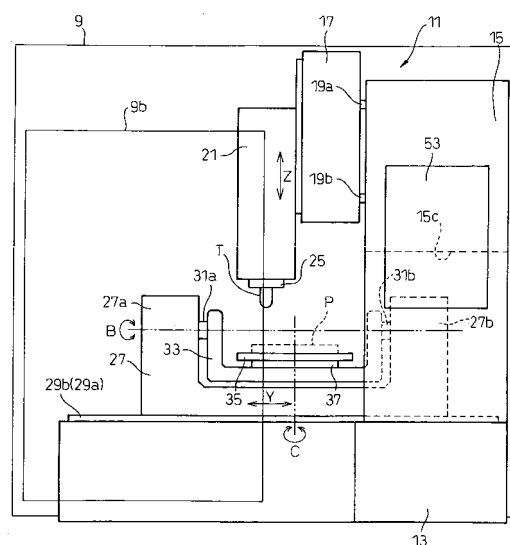
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(54) **MACHINE TOOL**

(57) A machine tool for machining a workpiece with a tool moved relative to the workpiece is provided with a bed (13) providing a base, a column (15) vertically mounted on the bed (13), and a carriage (27) having supporting columns (27a and 27b), disposed on either side thereof, for oscillatably supporting a table (35), the carriage being oriented so that one (27b) of the supporting columns (27a and 27b) is positioned adjacent the column (15) and the other (27a) of the supporting columns is positioned away from the column (15).

Fig.1



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Description

TECHNICAL FIELD

[0001] The present invention relates to a machine tool, having an oscillatory table, for machining a workpiece by moving a tool relative to the workpiece.

BACKGROUND ART

[0002] A multi-axis machine tool, having at least one rotary feed axis in addition to three orthogonal X-, Y- and Z-axis, is well known in the art. For example, JP-A-2006-305692 discloses a five-axis machining center provided with a pallet changer. The machining center includes a bed providing a base and a column vertically mounted on an upper face of the bed. In front of the column, the machined tool is provided with a trunnion type cradle which is movable linearly in Y-axis direction, perpendicular to the front face of the column, along the upper face of the bed. The cradle can further oscillate about a rotary feed axis, i.e., A-axis, parallel to the horizontal X-axis which is perpendicular to the Y-axis.

[0003] A table is mounted to the cradle for rotation about another rotary feed axis, i.e., C-axis, perpendicular to the A-axis. A pallet, on which a workpiece is mounted, is detachably attached to the table.

DISCLOSURE OF THE INVENTION

[0004] The above-described cradle of the machining center is supported for rotation about the A-axis parallel to the X-axis. The pallet is changed by a pallet changer arranged in a front portion of the bed. Accordingly, the machining center disclosed in JP-A-2006-305692 has a problem that the trunnion of the cradle obstructs an operator to access and/or to operate with the workpiece secured to the table. Furthermore, because an operator accesses the workpiece from a position close to the pallet changer, there is a possibility that the pallet changer may interfere with the operator when a malfunction is caused in the pallet changer.

[0005] Accordingly, the present invention is directed to solve the problems of the prior art, and the objective of the present invention to provide a machine tool improved to allow easier access for a workpiece whereby the workability and the safety of the machine tool are improved.

[0006] The present invention provides a machine tool for machining a workpiece with a tool moved relative to the workpiece, comprising a bed providing a base, a column vertically mounted on the bed, and a carriage having supporting columns, disposed on either side thereof, for oscillatably supporting a table to which a workpiece is mounted, the carriage being oriented so that one of the supporting columns is positioner adjacent the column and the other of the supporting columns is positioned away from the column.

[0007] Further, the present invention provides a machine tool for machining a workpiece with a tool moved relative to the workpiece, comprising a bed providing a base, a bed comprising a base, a column vertically mounted on one end portion in the longitudinal direction of the bed, a carriage mounted on an upper face of the bed for linear motion in the longitudinal direction of the bed, a table mounted on the carriage for oscillation about an oscillation shaft extending parallel to the longitudinal direction of the bed, a saddle mounted to a front face of the column for horizontal linear motion perpendicular to the longitudinal direction of the bed, and a spindle head, mounted to the saddle for vertical linear motion perpendicular to the horizontal linear motion of the saddle, for supporting a main spindle for rotation about a vertical axis, the main spindle holding a tool to face the table.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Figure 1 is a side view of a machine tool according to a preferred embodiment of the present invention. Figure 2 is a front view of the machine tool shown in Figure 1.

Figure 3 is a plan view of the machine tool shown in Figure 1.

Figure 4 is a schematic diagram showing a layout of a factory provided with the machine tools of the present invention.

THE MOST PREFERRED EMBODIMENT OF THE PRESENT INVENTION

[0009] With referene to the drawings, in particular Figures 1 to 3, the preferred embodiment of the present invention will be described below.

[0010] The machine tool 11 of the preferred embodiment of the present invention includes as main components a bed 13 providing a base, a column 15 vertically mounted on the upper face of the bed 13, a rotary table 35 arranged on the upper face of the bed 13 in the front of the column 15, a spindle head 21 supporting a main spindle 25 for rotation about a vertical axis (Z-axis) above the table 35, a saddle 17 supporting the spindle head 21 on the front face of the column 15, a pallet changer 39 arranged at one side of the bed 13, and an automatic tool changer 51 arranged between the pallet changer 39 and the column 15.

[0011] In this embodiment, the longitudinal direction of the table 35 (the right and left direction in Figure 1) is defined as a Y-axis. The direction perpendicular to both the Y-axis and the Z-axis, which is center axis for rotation of the main spindle 25, is defined as an X-axis. The present invention may include a machine tool in which the longitudinal direction of the table 35 is defined as an X-axis and the direction perpendicular to the X- and the Z-axis is defined as a Y-axis.

[0012] In the present embodiment, the entire machine tool 11 is generally surrounded by a cover 9. The cover 9 includes a pallet door 9a for the pallet changer 39 and an access door 9b for an operator to access a workpiece on the table of the machine tool 11 as described later. The pallet door 9a and the access door 9b are arranged on either sides of the bed 13. In this connection, in the present embodiment, the access door 9b provides an access means through which an operator accesses the workpiece on the table 35. The access means may further include a footstool or a step disposed at a side of the bed 13.

[0013] The column 15 includes a pair of leg portions which are apart from each other in the X-axis direction so that a cavity portion 15c is formed. A pair of X-axis rails 19a and 19b are extended along the front face of the column 15. The saddle 17 is mounted to the column 15 for reciprocation along the X-axis rails 19a and 19b. The column 15 includes, as an X-axis feed means, a ball screw (not shown) extending in the X-axis direction, and an X-axis feed motor (not shown) connected to one end of the ball screw. The saddle 17 includes a nut (not shown) engaging the ball screw. In the present embodiment, an operation panel 53 may be mounted to the side of the column 15 opposite to the pallet changer 39. The operation panel may have an input device (not shown) for operating the machine tool 11 and a display unit (not shown) for displaying the state of operation of the machine tool 11.

[0014] A pair of Z-axis rails 23a and 23b extend along a front face of the saddle 17. The spindle head 21 is mounted to the saddle 17 for reciprocation along the Z-axis rails 23a and 23b. The saddle 17 includes, as a Z-axis feed means, a ball screw (not shown) which extending in the Z-axis direction, and a Z-axis feed motor (not shown) connected to one end of the ball screw. The spindle head 21 includes a nut (not shown) engaging the ball screw.

[0015] The spindle head 21 supports the main spindle 25 for rotation about the Z-axis so that the distal end portion of the main spindle 25 faces the table 35. Tool T is attached to the extend of the main spindle 25. The spindle head 21 includes a drive motor (not shown) for rotationally driving the main spindle 25.

[0016] A pair of Y-axis rails 29a and 29b extend along the upper face of the bed 13. A carriage 27 is mounted to the upper face of the bed 13 for reciprocation along the Y-axis rails 29a and 29b. At least a portion of the carriage 27 can enter the cavity portion 15c of the column 15. The bed 13 includes, as an Y-axis feed means, a ball screw (not shown) which extend in the Y-axis direction, and a Y-axis feed motor (not shown) connected to one end of the ball screw. The carriage 27 has a nut (not shown) engaging the ball screw.

[0017] As shown in Figure 1, the carriage 27 is formed into a U-shape having a pair of supporting columns 27a and 27b which are apart from each other in the Y-axis direction. The supporting columns 27a and 27b rotatably

support a pair of oscillation shafts 31a and 31b extending inwardly along Y-axis. One of the oscillation shafts 31a and 31b is connected to a B-axis feed motor (not shown) for rotationally feeding the oscillation shafts 31a and 31b.

The B-axis feed motor is accommodated in one of the supporting columns 27a a 27b.

[0018] A U-shaped oscillating member 33 is connected to the ends of the oscillation shafts 31a and 31b. On the upper face of the oscillating member 33, a rotary table 35 is rotatably supported by a rotary shaft 37. A C-axis feed motor (not shown) for rotationally feeding the rotary table 35 is incorporated into the rotary shaft 37.

[0019] The pallet changer 39 includes a rotary arm 41 supported by a rotary shaft 43 perpendicular to the upper face of the bed 13, and a shifter 45. The shifter 45 is mounted on an upper face of the bed 13 for reciprocation along a pair of guide rails 47a and 47b extended in the X-axis direction. The rotary arm 41 is preferably mounted to the bed 13 so that one end portion can be positioned outside the cover 9. Incorporated into the bed 13 are a rotary motor (not shown), connected to the lower end of the rotary shaft 43, for rotating the rotary arm 41 and a hydraulic cylinder (not shown) for reciprocating the shifter 45 in the X-axis direction. The rotary arm 41 has a setup position 57, where one of the end portions is located outside the cover 9, and a handover position 59 wherein the cover 9 the pallet P is transported to the opposite end portion from the shifter 45 and vice versa.

[0020] According to the present embodiment, in the machine tool 11, one of the supporting columns 27a and 27b of the carriage 27 is positioned toward the column 15. Therefore, the pallet changer 39 can be positioned at one side of the bed 13. Accordingly, an operator of the machine tool 11 can access a workpiece on the table 35 from the opposite side of the bed 13 opposite to the pallet changer 39. Therefore, the workability and the safety of the machine tool 11 are remarkably improved.

[0021] Further, according to the present embodiment, when arranging a plurality of machine tools 11 in a factory, as shown in Figure 4, a workpiece conveyance line 61, including a conveyer and an automatic conveyance system, can be arranged at a side where the pallet changers 39 are disposed, and an access passage 63 for an operator can be arranged at the opposite side with respect to Y-axis. The workpiece conveyance line 61 and the access passage 63 can be clearly separated from each other in a factory as described above, and therefore, the safety in the factory can be remarkably improved:

[0022] Further, according to the present embodiment, the access doors 9b of the covers 9 can be arranged toward the access passage 63 opposite to the pallet changers 39 with respect to Y-axis. Therefore, the operator can directly access the machine tools 11 from the access passage 63. This arrangement in a factory cannot be accomplished by the conventional machining center described above.

[0023] Furthermore, according to the present embodiment, the operation panels 53, adjacent the access

doors 9b, can be also arranged near the access passage 63. Accordingly, an operator can directly access the operation panels 53 from the access passage 63. Therefore, the operability of the machine tools 11 can be remarkably improved.

[0024] According to another embodiment, instead of the pallet changer, an articulated robot detachably holding a workpiece may be employed as a workpiece changing means.

Claims

1. A machine tool for machining a workpiece with a tool moved relative to the workpiece, comprising:

a bed providing a base;
 a column vertically mounted on the bed;
 and
 a carriage having supporting columns, disposed on either sides thereof, for oscillatably supporting a table to which a workpiece is mounted, the carriage being oriented so that one of the supporting columns is positioned adjacent the column and the other of the supporting columns is positioned away from the column.

2. A machine tool for machining a workpiece with a tool moved relative to the workpiece, comprising:

a bed providing a base;
 a column vertically mounted on one end portion in the longitudinal direction of the bed;
 a carriage mounted on an upper face of the bed for linear motion in the longitudinal direction of the bed;
 a table mounted on the carriage for oscillation about an oscillation shaft extending parallel to the longitudinal direction of the bed;
 a saddle mounted to a front face of the column for horizontal linear motion perpendicular to the longitudinal direction of the bed; and
 a spindle head, mounted to the saddle for vertical linear motion perpendicular to the horizontal linear motion of the saddle, for supporting a main spindle for rotation about a vertical axis, the main spindle holding a tool to face the table.

3. The machine tool according to claim 2, further comprising:

workpiece changing means, mounted at one side of the bed with respect to the longitudinal direction of the bed, for changing a machined workpiece on the table with a non-machined workpiece; and
 access means for allowing to access a workpiece on the table from the side opposite to the

workpiece changing means with respect to the longitudinal direction of the bed.

4. The machine tool according to claim 3, wherein the workpiece changing means comprises a pallet changer for changing a pallet to which a workpiece is mounted.

5. The machine tool according to claim 4, wherein the pallet changer includes:

a rotary arm rotatable about a vertical axis; and
 a shifter arranged between the rotary arm and the table for reciprocation in the horizontal direction perpendicular to the longitudinal direction of the bed, the shifter receiving a non-machined workpiece mounted to a pallet from the rotary arm together with the pallet to transport them to the table, and also receiving a machined workpiece mounted to a pallet from the table together with the pallet to transport them to the rotary arm.

6. The machine tool according to claim 3, wherein the workpiece changer comprises an articulated robot for detachably holding a workpiece.

7. The machine tool according to claim 2, the table including:

an oscillating member having an oscillation shaft extending parallel to the longitudinal direction of the bed and attached to the carriage for oscillation; and
 a rotary table mounted on an upper face of the oscillating member for rotation about a vertical axis.

Fig.1

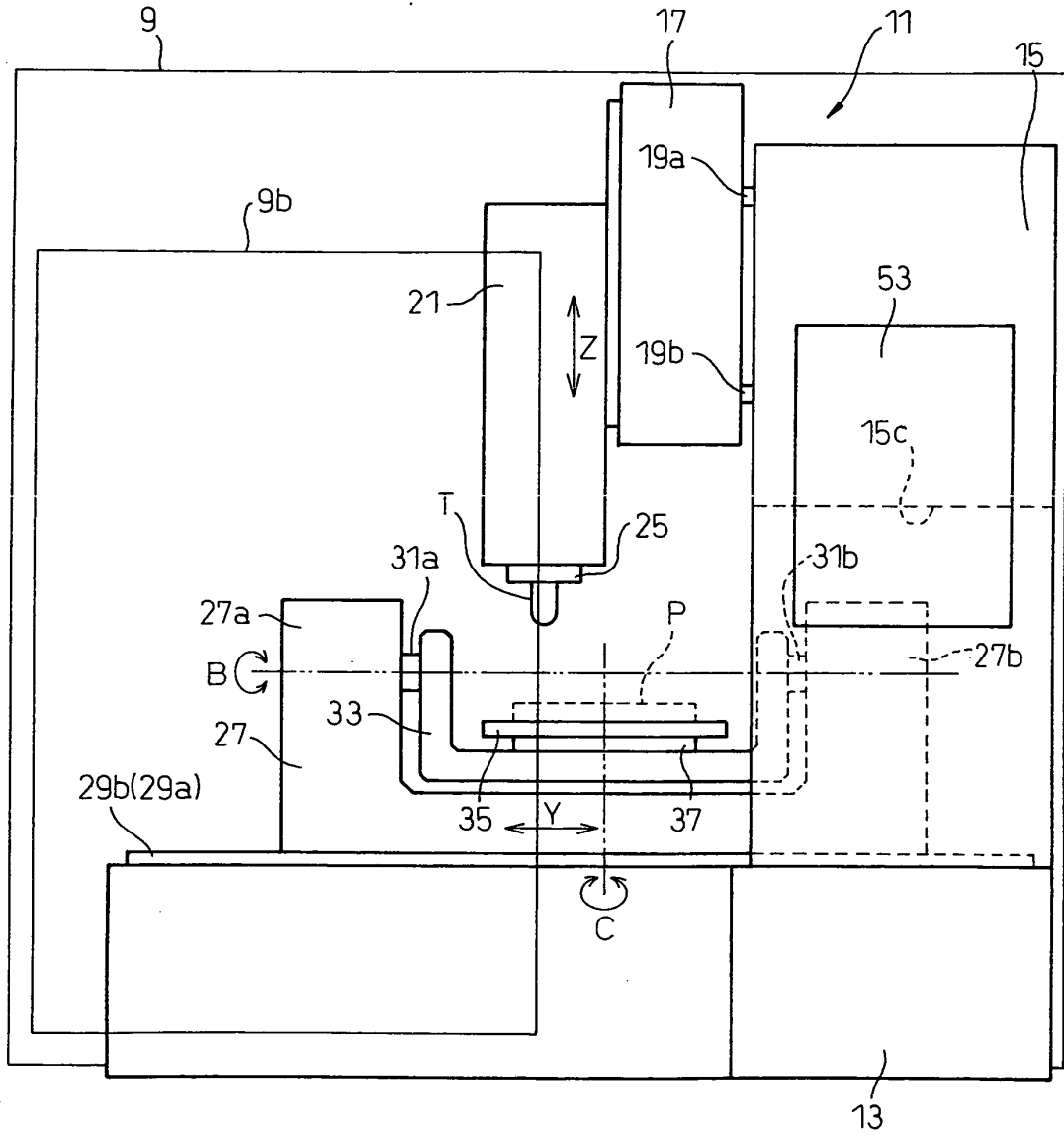


Fig.2

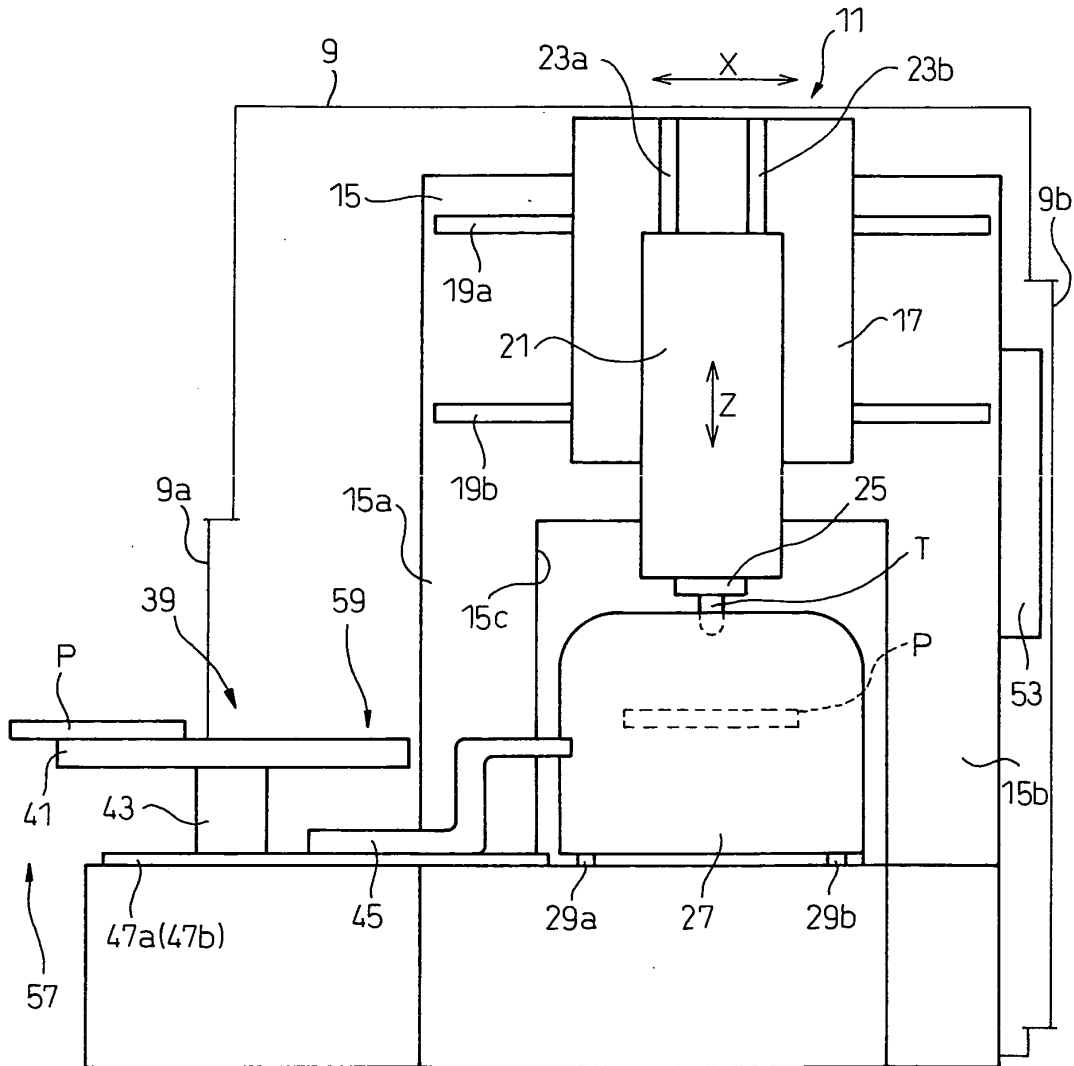


Fig.3

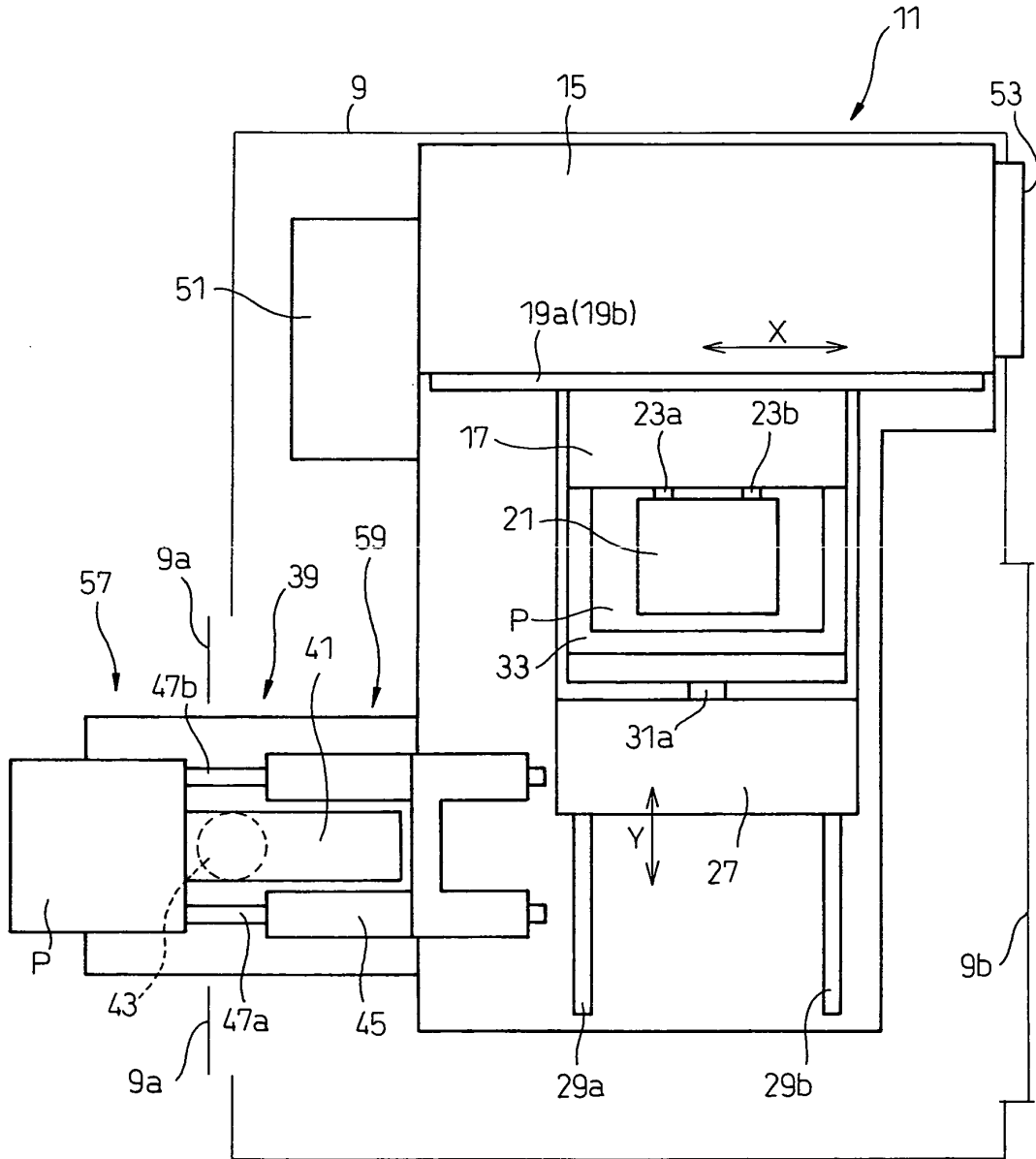
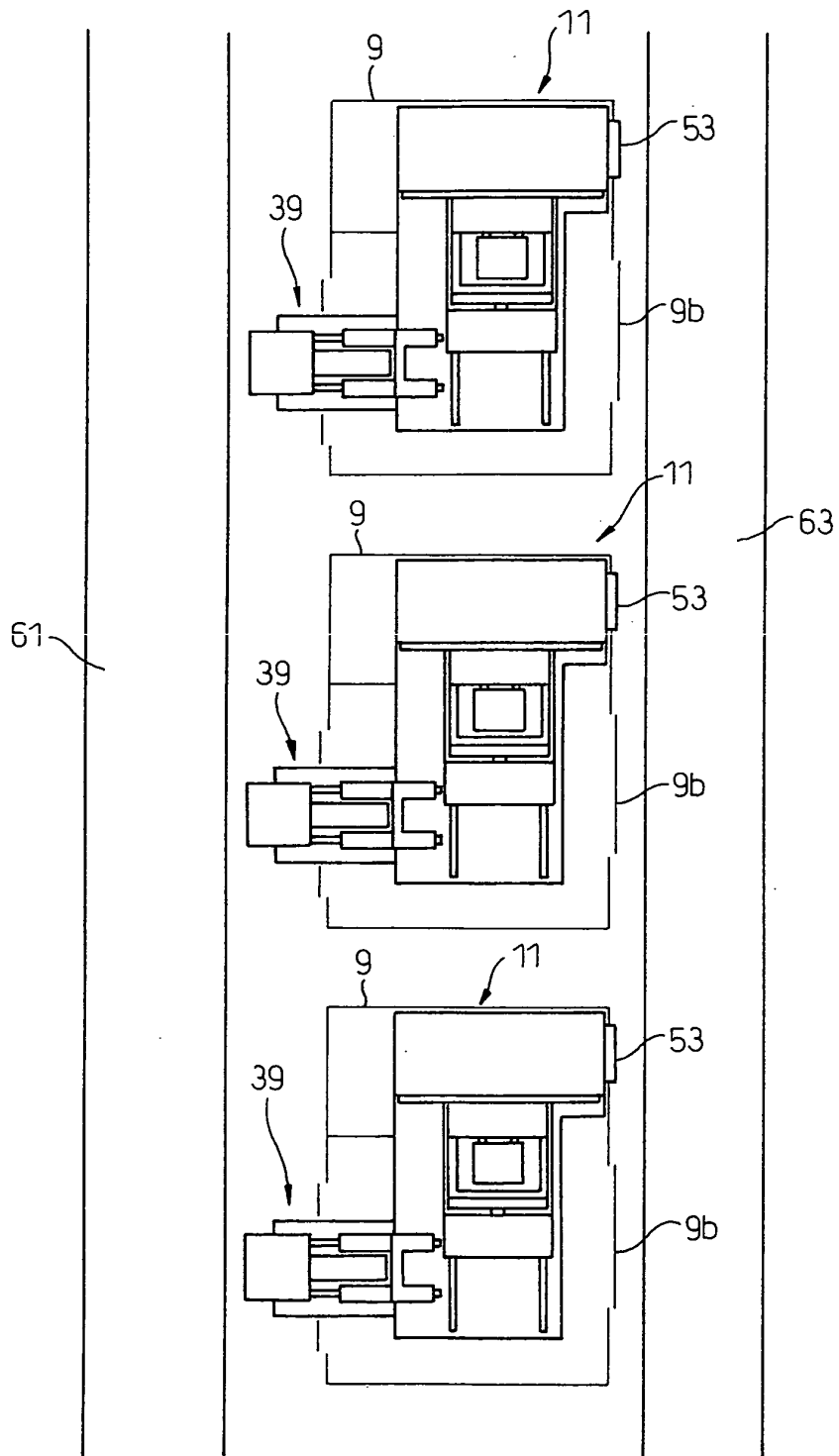


Fig.4



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2008/060108

<p>A. CLASSIFICATION OF SUBJECT MATTER B23Q1/48(2006.01)i, B23P23/00(2006.01)i, B23Q1/00(2006.01)i</p> <p>According to International Patent Classification (IPC) or to both national classification and IPC</p>												
<p>B. FIELDS SEARCHED</p> <p>Minimum documentation searched (classification system followed by classification symbols) B23Q1/48, B23P23/00, B23Q1/00</p> <p>Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2008 Kokai Jitsuyo Shinan Koho 1971-2008 Toroku Jitsuyo Shinan Koho 1994-2008</p> <p>Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)</p>												
<p>C. DOCUMENTS CONSIDERED TO BE RELEVANT</p> <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>Y</td> <td>JP 2007-526136 A (OPS-Ingersoll Funkenerosion GmbH.), 13 September, 2007 (13.09.07), Par. Nos. [0020], [0029] to [0031], [0038]; Fig. 3 & US 2007/0196192 A1 & WO 2005/084881 A1 & DE 102004010984 B3</td> <td>1-7</td> </tr> <tr> <td>Y</td> <td>JP 10-180523 A (Deckel Maho GmbH), 07 July, 1998 (07.07.98), Par. No. [0014]; Figs. 1, 2 & US 5909988 A & EP 0835708 A2 & DE 19641831 A1</td> <td>1-7</td> </tr> </tbody> </table>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	Y	JP 2007-526136 A (OPS-Ingersoll Funkenerosion GmbH.), 13 September, 2007 (13.09.07), Par. Nos. [0020], [0029] to [0031], [0038]; Fig. 3 & US 2007/0196192 A1 & WO 2005/084881 A1 & DE 102004010984 B3	1-7	Y	JP 10-180523 A (Deckel Maho GmbH), 07 July, 1998 (07.07.98), Par. No. [0014]; Figs. 1, 2 & US 5909988 A & EP 0835708 A2 & DE 19641831 A1	1-7	
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<p><input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.</p>												
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<p>Date of the actual completion of the international search 28 July, 2008 (28.07.08)</p>		<p>Date of mailing of the international search report 05 August, 2008 (05.08.08)</p>										
<p>Name and mailing address of the ISA/ Japanese Patent Office</p>		<p>Authorized officer</p>										
<p>Facsimile No.</p>		<p>Telephone No.</p>										

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2008/060108

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2004-34168 A (Mitsubishi Materials Corp.), 05 February, 2004 (05.02.04), Claims 1, 5; Par. Nos. [0015], [0032] to [0037], [0045] to [0052]; Figs. 1, 7 & KR 10-2004-0002748 A	2-7
Y	JP 2006-346799 A (Mitsubishi Materials Corp.), 28 December, 2006 (28.12.06), Claims; Par. Nos. [0034] to [0036]; Figs. 1, 2 (Family: none)	6

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REFERENCES CITED IN THE DESCRIPTION

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